Description

Method for operating a short-haul radio transmitting/radio receiving system conforming to a short-haul radio communication standard and a master device for implementing said method

The invention relates to a method for operating a short-haul radio transmitting/radio receiving system conforming to a short-haul radio communication standard according to the preamble of claim 1 and to a master device for implementing said method according to the preamble of claim 7 [sic].

The Bluetooth standard is a short-haul radio standard that functions using carrier frequencies from the globally non-licensed "Industrial", "Scientific", "Medical" (ISM) 2.4 GHz band and enables wireless connecting of terminals (devices) in a radio cell having a radius of up to 10 meters, in special cases even up to and above 100 meters, with said carrier frequencies being changed in a (pseudo) random sequence up to 1600 times a second in order to prevent radio interference. Up to 79 frequencies (channels) in the range between 2.402 and 2.480 GHz are provided for this what is termed "frequency hopping" technique.

Up to eight devices operating in conformity with the Bluetooth standard can be combined in the radio cell, referred to also as a "pico cell", into a network termed a "piconet" and communicate with each other, with its being possible in a manner implemented using time-division multiplex techniques for the individual devices to be members of a plurality of piconets so that said piconets are linked thereby into what is termed a "scatter network".

Each device in a piconet is able to initialize the network. Since a device that has initialized a piconet controls said piconet's other members and synchronizes their timers it is referred to as the "master" (device master), while said piconet's other members are referred to as "slaves".

Devices that are members of a plurality of piconets and which combine said piconets, distinguishable by different hopping-channel sequences, into scatter networks, synchronize themselves in each multiplex timeslot with the respectively current master.

Prior to establishing a connection in the piconet, Bluetooth devices are in a power-saving "standby mode". This is not a power-saving mode in the Bluetooth sense but signifies rather that the device has been initialized and is ready to establish or accept connections. There is accordingly no cyclic searching for messages in the network in this condition, there being no network at this time. A response is made at most to a device search (inquiry). However, this process is initiated by another device (remote device) so is not subject to a time scheme.

A number of further power-saving functions are possible apart from standby mode without a network connection. In the "hold mode" the device remains integrated into the piconet but no data is transmitted. Only an internal timer continues running in the slave. When necessary, data transmission will start without any delay. The hold mode can be directed for the slave by the master. On the other hand, the slave can request the master to switch it to said mode.

In the "sniff mode" the device listens to the network at programmable intervals. Here, too, the timer for synchronizing continues running in the slave.

It is furthermore possible to park devices in the network ("park mode"). Then losing its address in the network, the device will henceforward only be able to keep track of the network traffic and will synchronize its internal timer with that of the master at longer intervals.
It is disadvantageous that a master device conforming to, for example, the Bluetooth standard can communicate only with a maximum of 7 further devices.

The documents XP-000968001, US 2002/0193073 A1, and XP-001067139 disclose that when there are more than 7 devices the devices exceeding the number 7 will be switched to a park mode and that, continually in keeping with a predefined strategy, parked devices will be switched to active and active devices to parked.

It is disadvantageous that when a parked device is to be switched to active an active device first has to be switched to parked. That takes time, which the device requiring to be switched to active must wait to elapse before it can be switched to active.

The object of the present invention is to disclose a method and a master device by means of both of which the maximum number of devices able, as specified by a standard such as, for example, the Bluetooth standard, to communicate with each other are split up in such a way that when there are devices exceeding said specified maximum number, devices requiring to be switched to active can be switched to active as quickly as possible.

In terms of the method, said object is achieved according to the invention, proceeding from a method of the type mentioned at the start, by means of a method having the procedural step indicated in the characterizing part of claim 1. In terms of the master device, said object is achieved according to the invention by means of a master device having the feature recited in the characterizing part of claim 6.

In terms of the method, not only the number of devices exceeding, according to a present standard, the maximum number of devices able to communicate with each other are switched to a park mode and not only the devices switched to the park mode are switched continually in keeping with a predefined strategy to active and active devices to parked.

According to said method, at least one further device is switched to the park mode in addition to the minimum number of devices requiring to be switched to the park mode. This has the advantage that a device can be switched quickly to the active mode and another device will not first have to be switched to the park mode. An accelerated procedural flow will be ensured thereby.

In terms of the master device, the master device has a device manager that controls the above-described method according to the invention in an appropriate manner.

Advantageous embodiments of the invention are the subject of subclaims.

If the strategy of proceeding in timeslices is employed for switching parked devices to the active mode, that will have the

advantage that none of the parked devices will have to wait too long for its own turn.

If the strategy of taking priority criteria into consideration is employed for switching parked devices to the active mode, that will have the advantage that operations given a higher priority will be carried out more quickly.

If a mixture of the strategies described above is employed for switching parked devices to the active mode, that will further optimize the overall flow.

One possibility for taking priority criteria into consideration is to analyze and suitably take account of the data rates of the devices.

An exemplary embodiment of the invention is explained in more detail below with reference to a drawing, in which:

Figure 1 is a schematic of a protocol stack having a supplement according to the invention, and
Figure 2 is a schematic of the flow of the method according to the invention.

Figure 1 shows functional units of a "protocol stack" (stack) SURFBLUE implementing the method according to the invention, with a "protocol stack" understood generally as being protocol software for adjacent, interdependent layers of the OSI reference model that functionally belong together. Said software generally serves to implement specific network architectures.

The architecture of the SURFBLUE stack shown is implemented in a host HOST accommodating a Bluetooth module, and communicates with other layers (application and transport layer) or, as the case may be, with BT APPLICATION, DRIVER, and TRANSPORT LAYER units assigned thereto, via an external interface 1 provided for the purpose.

The SURFBLUE stack has a plurality of protocols. One protocol specified according to the Bluetooth standard (core protocol) is the "Logical Link Control and Adaptation Protocol" L2CAP which, for stackable protocols, enables connection-oriented and connectionless (loopback) connections for higher protocol layers.

The Logical Link Control and Adaptation Protocol L2CAP has a connection to a "Telephony Control protocol Specification" TCS via an internal interface 2. Said Telephony Control protocol Specification TCS generally on the one hand includes a bit-oriented protocol which implements ring control, connection setup, voice transmission, and data transmission; on the other hand it issues AT commands for cell phones and modems for controlling these or for a type of FAX transmission.

The Logical Link Control and Adaptation Protocol L2CAP is additionally connected via the internal interface 2 to a serial cable emulation protocol RFCOMM defined according to ETSI ZS 07.10 and serving above the Logical Link Control and Adaptation Protocol L2CAP to emulate an RS232 connection, such as ETSI TS 07.10 in the case of GSM, for example for direct controlling via AT commands.

Via the internal interface 2 the Logical Link Control and Adaptation Protocol L2CAP furthermore has a connection to a

locating protocol (Service Discovery Protocol) SDP which is responsible for locating the services offered by Bluetooth devices within radio range and itself communicates via the internal interface 2 with the adaptation layer ADAPTATION of the OSI reference model.

The Logical Link Control and Adaptation Protocol L2CAP furthermore also communicates with a Host Controller Interface HCI which is necessary when a Bluetooth device is controlled via the host HOST.

For this purpose the Host Controller Interface HCI communicates with a plurality of the described protocols and layers such as, for instance, the ADAPTATION layer, via the internal interface 2, or the TRANSPORT layer, via the external interface 1.

For implementing process management or, as the case may be, operating the SURFBLUE stack, the SURFBLUE stack has a few further modules such as, for instance, the SECURITY-MANAGEMENT module for implementing security-relevant processes that is connected therefor via the internal interface to at least the Logical Link Control and Adaptation Protocol L2CAP, the locating protocol SDP, and the Host Controller Interface HCI, the DI-MANAGEMENT module for implementing device interface management, and an RX/TX-BUFFER MANAGEMENT module for implementing receive/transmit buffer management.

The protocol stack SURFBLUE furthermore has a power-saving device POWER-SAVE MANAGER and, for implementing the method according to the invention, a device manager DEVICE MANAGER that is connected to at least the adaptation layer ADAPTATION via its own adaptation layer power management interface 3 and the Host Controller Interface via an HCI Host Controller

Interface power management interface for implementing the exemplary embodiment, shown in Figure 2, of the method according to the invention.

With reference to Figure 2, the following factors have been taken into account in order to simplify the presentation of the facts.

The maximum possible number of active devices is 3. The maximum number of devices that can be switched to the park mode is 3. The devices G1, G2, and G3 send data. The device G4 does not send any data.

At the start of the exemplary embodiment the device G3 is in the park mode. The letter A stands for an active device. The letter P stands for a parked device. The sequence of letters MUX stands for a device which, although it sends data, is switched to the parked mode and is waiting to be switched to the active mode again. The letter M designates the master device performing controlling.

It is further assumed in Figure 2 that a possibility of switching a device to the active mode has been reserved.

Proceeding from the device G3, which wishes to send data and is in the parked mode, said device G3 will be switched to the active condition.

This requires, for example, switching the device G1 to the parked condition at this point. The device G1 will still continue to send data until the data memory is full. The device G1 will then wait until it is switched to the active condition again. That will be the case when another connection has

finished transferring data. When it has, the device G1 will be switched to the active condition again.

This requires, for example, switching the device G2 to the parked condition at this point. The device G2 will still continue to send data until the data memory is full. The device G2 will then wait until it is switched to the active condition again. That will be the case when another connection has finished transferring data. When it has, the device G2 will be switched to the active condition again.

This requires, for example, switching the device G3 to the parked condition at this point. The device G3 will still continue to send data until the data memory is full. The device G3 will then wait until it is switched to the active condition again. That will be the case when another connection has finished transferring data. When it has, the device G3 will be switched to the active condition again.

This requires, for example, switching the device G1 to the parked condition again at this point, and the operation will resume at the point X1. It would also have been possible for the operation to resume at the point X2.